STANFORD RESEARCH INSTITUTE

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October 2, 1967

Mr. Larry Roberts
Rm. 3D-169
The Pentagon
Washington, D.C. 20301

Dear Larry:

Enclosed are two memoranda entitled "Some Thoughts Regarding the Interface Between the Primary Processor and the Message Processor," and "A Proposed Set of Objectives and Major Requirements for the ARPA Computer Network," dated 11 August and 25 September, respectively. These documents are an attempt to put into writing many of the ARPA network notions that have been put forth, as of this date, by all concerned.

It is hoped that these documents can contribute to an introduction to the IMP requirements.

Very truly yours,

Elmer B. Shapiro
Senior Research Engineer

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0 (ebsmp2) Some Thoughts Regarding the Interface Between the Primary Processor and the Message Processor

0a EB SHAPIRO 11 AUG 67

0b Distribution: 5890 File, (illegible)

1 Introduction

1a This memorandum discusses, in broad terms, the author's thoughts on the nature of the interface between the primary processor (PP) and the message processor (MP) at a node in the ARPA computer network. It is hoped that such a discussion will provide a useful prelude to the detailed definition of the interface. This interface is of importance for it affects the hardware and program design of the MP; it also affects the hardware and program modifications necessary at the PP to accommodate network operation.

2 What Is the Interface and Where Is It

2a The interface is a cut across all signal paths between the PP and MP. When these paths are cut at the interface it is impossible for:

2a1 the PP to gain any information regarding the state of the MP or of the network, or

2a2 the MP to gain any information regarding the PP.

2b It is possible to make such a cut at more than one place; it is necessary, then, to define the location of the cut. Consider Figures 1, 2 and 3.

2c For the simple example of Figure 1, it is clear that the cut as shown constitutes the interface, machine A is the PP, and machine B is the MP. For the examples of Figures 2 and 3 there is, in addition to the interface location question, the additional question as to whether a coupler is regarded as part of the PP, MP, or a separate entity.

2d It is proposed that the interface of concern always be that cut closest to machine B, i.e., cuts 1, 3, and 6. In addition, it is proposed that machine B be conceptually regarded as being the MP, and all other element (machine A, couplers C, D, and E) be regarded as constituting the PP.

2e What then defines machine B. Let machine B be defined to be that largest set of hardware and program code and data present for the purposes of network operation at all nodes. This definition, being conceptual, may differ from the physical realization of the nodes. In particular, the physical unit housing the MP may also house some non-MP hardware, program code, and data.

3 Interface Components

3a The specification of the interface should cover the logical properties of the exchanged signals, their electrical properties, and the physical properties of the media used to transport the signals. A form of check list is presented below for each set of properties.

3a1 Logical Properties

3a1a Name assigned to each signal.

3a1b Signal's source (PP or MP) and sink (MP or PP).

3a1c Meaning of signal when it has the binary value of 1, of 0.

3a1d Combinatorial interrelationship of a given signal with other signals, e.g., coding, weight, format.

3a1e Sequential interrelationship of a given signal with other signals, e.g., time sequential patterns.

3a1f Synchronization mechanisms for controlling information transfers.

3a1g Statistics regarding rates of occurrence of significant information patterns, and control patterns.

3a2 Electrical Properties

3a2a Voltage and current levels of signals.

3a2b Impedances of sources and sinks.

3a2c Critical timing parameters.

3a2d Conventions regarding true and false signals in terms of voltages or currents.

3a3 Physical Properties

3a3a Cables and connectors used.

3a3b Length limitations.

3a3c Signal assignments to connector pins and cable conductors.

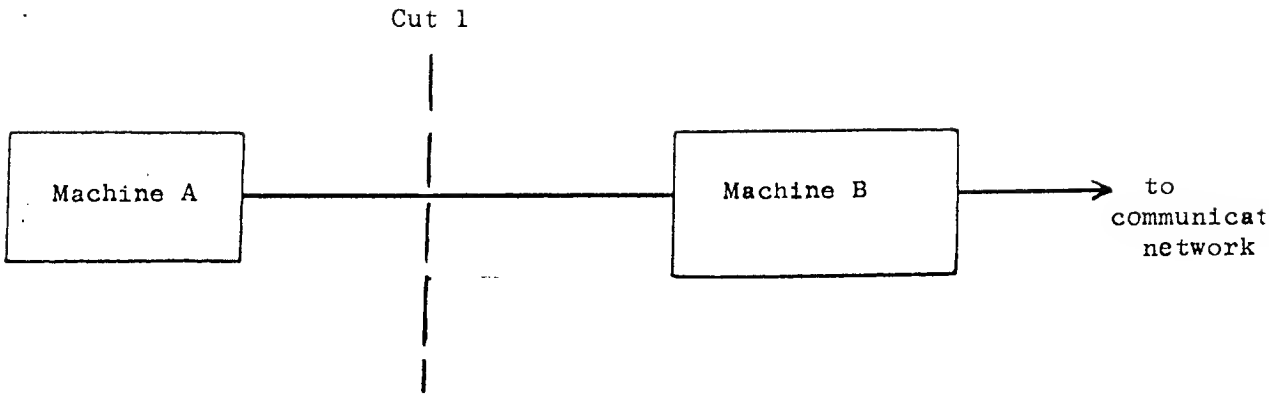

Figure 1

Direct Machine-to-Machine Coupling

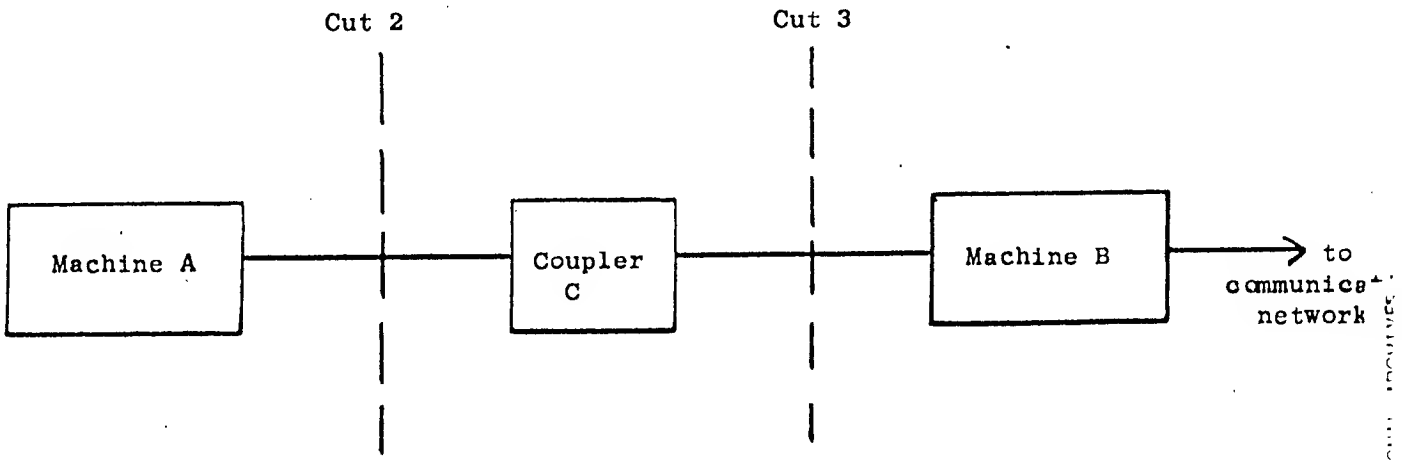

Figure 2

Coupling via a Single Coupler

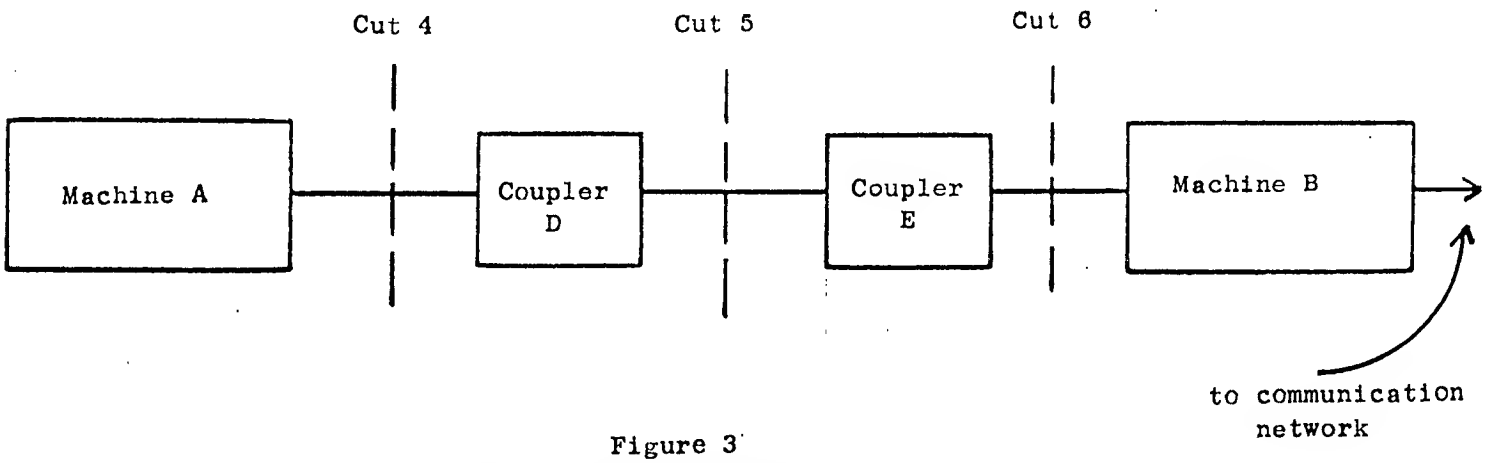

Figure 3

Coupling via Two Couplers

0 (ebsmp3) A Proposed Set of Objectives and Major Requirements for the ARPA Computer Network

0a EBSHAPIRO 25 SEP 67

0b Distribution: Project 5890 File

1 Broad Objectives

1a A data communication network is to be created, consisting of communication circuits and switches, and computer programs and hardware.

1b The network is to interconnect many diverse computers of ARPA contractors located in major geographical areas of the United States. The network will permit these computers to exchange information in a rapid, economical manner.

1c The network is to provide services that facilitate those contractor research activities that are dependent upon rapid information exchanges between computers. Users employing on-line and off-line techniques, moving programs and data, are to be accommodated.

1d The network itself should be available as a subject for study and experimentation.

1e The network design process should identify those problems hindering the creation of large computer networks, possible solutions, not necessarily those actually adopted, should be pointed out.

1f The network should be constructed in a manner that minimizes the disturbance its introduction causes to the programs, hardware, and performance of the contractor's computer systems.

2 Major Requirements

2a An element of the communication network will be a computer to perform the functions of a message processor (MP). An MP could be provided at the contractor's site, interposed between the contractor's computer system and remainder of the network.

2b It shall be possible for the contractor to cause his computer system, here called the primary processor (PP), to have direct access with the network, dispensing with the need for an MP. Under these conditions, the PP must perform the functions normally performed by the MP.

2c The facilities of the common carriers will normally be used to provide switched, and non-switched point-to-point circuits. All circuits should provide full duplex service. Typically, a one-way transmission speed of 2400 bits per second will be used. It is anticipated that a limited number of circuits will use speeds up to 50,000 bits per second.

2d Four sets of network conventions will be established. They will deal with communications between:

2d1 MP's and the communication facilities

2d2 MP's and MP's

2d3 PP's and MP's

2d4 PP's and PP's.

2e The operation of the communication network, under normal conditions, should not require the use of human intervention. Normal operating conditions involve the "dialing" and "answering" of calls, "disconnection" of calls, and routine transmission, switching, and operational malfunctions of the communication facilities.

2f Information transfers throughout the computer network shall be basically asynchronous in nature. The asynchronous behavior should permit any MP or PP to suspend information transfers in an orderly manner when problems of shortage of storage, data or processing capability temporarily arise. The asynchronous approach may apply to character, word, block or message transfers, depending upon the application at hand. With this approach synchronous operation, say over the span of a data block, can be accommodated.

2g The traffic routine doctrine of the network should accommodate:

2g1 A network containing a maximum of 100 PP's

2g2 PP's served by several MP's

2g3 MP's equipped to terminate transmission circuits

2g4 Selected MP's used for purposes of traffic concentration and distribution for "nearby" MP's

2g5 MP's or PP's being unavailable to the network on a scheduled and a non-scheduled basis.

2h Consideration should be given to the use of existing and proposed USASA standards as applied to character codes, communication control processes, and program languages. In particular USASCII should be used for the coding of textual characters exchanged via the communication facilities.

2i It shall be possible for PP's of differing word lengths to exchange binary information without incurring any information loss.

2j Error detection and correction procedures shall be used in communicating between MP's. The error rate in the information exchanged between PP's should be less than 1 bit in 10**6. The MP's shall take protective actions, including the temporary cessation of data transmission on affected circuits, when excessively high error rates are encountered.

2k Safeguards must be provided by the PP's and MP's to prevent unauthorized access to MP's and PP's. These safeguards should apply to attempts (intentional or as the result of an error) to:

2k1 Connect from the "outside" into the network,

2k2 Connect from the network to the "outside,"

2k3 Modify the programs or access other information of an MP,

2k4 Modify the programs or access other information of a PP.

21 The network should provide for easy additions and deletions of PP's and MP's to the list of authorized network nodes. Likewise, the network should provide for changes in the inventory of communication circuits and switches. The response to a change should be less than one day.

2m The network should be able to handle messages as short as one character (of 7 bits, excluding redundancy bits) and as long as an infinite number of characters.

2n Two message priorities should be used--immediate and deferred. Typically, the priority of a message can be related to its size; thus, a message of about 2,000 characters could be classified immediate, and all other (i.e., larger) messages could be deferred. Where access conflicts occur, usually for communication circuits, immediate messages would be served before deferred ones. If a deferred message is being served, it may be interrupted to provide service to an immediate message.

2o The basic programs and hardware of all the MP's are to be identical. However, at any given contractor site, auxiliary programs and equipments may be appended to the basic MP to enable the MP to directly couple to the PP.

2p The nature, structure, and documentation pertaining to the basic MP should be such as to facilitate modifications to the MP by the personnel serving the PP. In particular, the basic MP programs should be written in a compiler language. The documentation procedures should be such as to facilitate the recording of the work of contractor personnel as it affects their MP.

2q Two versions of a compiler for the MP should be provided. One version should run on the MP when the MP is not performing network functions. To this end, eight-hole punched paper tape should be an input-output medium of the MP. A second version should run on at least one PP of the network. Access to that PP should be possible either via the network or "directly" via a Model 33, 35, or 37 Teletypewriter (TTY). The object code should be returnable to the user via the network or to the TTY. In the latter event, a paper tape output from the TTY should be suitable for reading by the MP.